Art. X.—*Notes on Some Observations of Atmospheric Electricity.*

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Some years ago I described to you an apparatus which I had arranged for obtaining a continuous record of the electrical condition of the atmosphere at the Melbourne Observatory, which was a modification of the exquisite electrometers devised by Sir William Thompson. This apparatus was in operation for several years with most satisfactory results, and a valuable series of records were obtained. It was found, however, almost impossible to maintain the instrument in perfect working condition in some states of the atmosphere, through the subtle nature of the force dealt with and the difficulty of maintaining the requisite insulation of all parts of the apparatus. In consequence of this, the working of the instrument had to be frequently interrupted for improvements in the methods of insulation and of collecting the electricity from the air; and, I regret to say, eventually stopped altogether until a more efficient plan for insulation could be obtained.

It is, however, with respect to the results of some observations with this instrument that I now wish to say a few words; but I will at first briefly refer to the generally accepted theory of the distribution of electricity over the earth's surface.

As a rule, the potential of the earth's surface is negative relative to that of the air above it. Exceptions to this, however, sometimes occur. Generally speaking, I have found in quiet and fine weather that if the air has a certain electric potential, say six feet from the ground, a contour of an equi-potential line traced over the ground, buildings, trees, &c., will be approximately six feet from the surface of such portions of the earth's surface; the line will, however, usually approach the summit of a building, hill, or tree, to something less than six feet; and as the potentials of higher strata are contoured this difference decreases, so that at a few hundred feet the equi-potential lines will probably be found to be parallel to the earth's surface. This is only the case in very serene weather, for in wind, rain, fog, or dust, the case is very different, and nothing more variable than the electric condition of the air can well be conceived, and

widely different potentials of the air the same height from the ground in two different places but little removed from one another will be constantly found; and even in the most serene days, when no clouds are seen, no disturbance apparent, sudden and inexplicable variations sometimes occur.

The passing of clouds constantly alters the electric condition of the air on the earth's surface; and indeed all the induction and other phenomena which one can exhibit at the lecture table with an electric machine are in almost incessant operation in the earth's atmospheric envelope. In observing the electric condition of the air we adopt Sir William Thompson's method, and select a certain stratum of air, say six or eight feet from the ground and four to six feet from the walls of any building or other object projecting above the surface of the ground, and the collecting point is always maintained in this position; the measurement given by the apparatus being the difference of potential between the surface of the earth and the air at the selected point. If the air is at the same potential as the earth the instrument will indicate zero, if it be at a higher potential it will indicate above zero, and below if at a lower; the latter state of things may be considered as abnormal. The unit of measurement adopted is the difference of potential between the two poles of a galvanic battery cell, so that the statement that the electric potential of the air at six feet above the ground was equal to 300 Daniell's elements means that the difference of potentials between the air and the surface of the ground was equivalent to that between the two poles of a Daniell's battery composed of 300 cells.

The photographic curves obtained with our electrometer have not yet been tabulated, but some facts have already been deduced, of which the following perhaps are the most interesting:—

In calm and serene weather a regular diurnal maximum and minimum are very marked, the highest part of the curve taking place about 7 a.m. and the lowest about 2 p.m. A second maximum about 9.30 p.m., and a second minimum about 1 a.m., are also indicated.

Hot winds are always accompanied by strong negative tension, and more especially so if dust is present in the air, when sparks can often be got from the collector. The usual turning of the wind from north to south-west is always accompanied for a short period by a high positive tension. In squally weather, rapid and large variations from low nega-

tive to high positive generally occur; and during continuous rain strong negative tension is frequently present, which gradually gives place to an increasing positive one some little time before the rain ceases. In very heavy rains, however, the air seems to be reduced to zero, or the same potential as the earth's surface.

It has also been noticed that, if after continuous rain it clears up, the setting-in of rain again is usually preceded by a gradually increasing negative tension. Fogs are always accompanied by a high positive condition.

In the course of some experiments on a very fine day, for the purpose of ascertaining the best position for placing the collector of our electrometer, the following notable results were obtained:—The electric condition of the air being normal (positive potential), when an insulated conductor connected with the electrometer was rapidly raised from the surface of the ground to the height of about 20 feet, a large and rapid increase of positive electricity was shown; and when the conductor was as rapidly lowered, a corresponding diminution was observed. If the conductor was moved rapidly from south to north, keeping it at as nearly the same height from the ground as possible, a strong positive indication was noted, while moving it from north to south the reverse took place. Moving it from east to west gave strong positive, while moving it from west to east gave a strong negative indication.

In repeating these experiments a few days ago in a hot wind, when the air had a strong negative potential, the following results were obtained:—

Raising the conductor gave a strong negative indication, and lowering it a strong positive.

Moving the conductor from south to north gave a strong negative, and from north to south a strong positive indication. Moving the conductor from east to west gave also a strong negative, while moving from west to east gave a strong positive indication.

These results are exactly opposite to those obtained in the first experiments, and can no doubt be accounted for by the negative potential of the air which prevailed at the time.

It must be remarked that in these experiments the indications of the electrometer *took place during the motion of the conductor*, and that immediately the conductor was at rest in its new position the reading of the electrometer became normal for the position the conductor was then in.

To give an idea of the extent of these indications, I may state that with an electrometer where one Daniell's cell will deflect five divisions, the following average readings were obtained :—

		Scale reading.
Zero 125.	Raising the Conductor 18 feet ...	50
	Lowering ,, ,, ...	250
	Moving N. to S. ,, ,, ...	150
	,, S. to N. ,, ,, ...	40
	,, E. to W. ,, ,, ...	60
	,, W. to E. ,, ,, ...	160

I obtained some very interesting results some years ago from observations made on the summit of Mount Macedon while a terrific thunderstorm was passing over Melbourne and the surrounding level country.

Over the mountain it was quite clear, fine, and calm, while the plains below were hidden from view by a dense stratum of low-lying cloud, in and through which incessant lightning could be seen, while occasionally the low and distant roll of thunder could be faintly heard.

The electrometer was placed in a tent at the bottom of the tower used for trigonometrical observation, and was connected with the collector (burning fungus) on the tower 50 feet high. The potential of the air was slightly positive and quiet; but simultaneous with every flash of lightning the electrometer became violently but momentarily depressed with negative electricity, and instantly returning to its normal positive indication, suggesting the occurrence of a sudden electric vacuum with each flash of lightning.

These then are some of the most prominent facts deduced from our observations of atmospheric electricity up to the present time. They are interesting so far as they go, but are scarcely sufficient in the present state of our knowledge of the subject for tracing the relations which exist between the electric condition of the earth's surface and other atmospheric phenomena, although we may hope as our observations are extended (for I propose to resume them) this will be eventually accomplished. Not the least interesting or valuable point for investigation in this subject is the effect the various electric conditions of the air have on the human or animal economy, both in health and disease; for I am convinced from what I have already observed that it plays a most important part in this direction, and I intend at some future time to make a communication to the Society on this branch of the subject.